

BELLCOMM, INC.

955 L'ENFANT PLAZA NORTH, S.W.

WASHINGTON, D.C. 20024

869 08046

SUBJECT:  $\Delta V$  Cost of Updating the Landing Site During the LM Descent Braking Phase - Case 310

DATE: August 21, 1969

FROM: F. LaPiana  
P. A. Whitlock

ABSTRACT

The technique of updating the landing site through the DSKY during the LM descent braking phase is being investigated for effectiveness and  $\Delta V$  cost. A study was made using the Bellcomm Powered Flight Performance Simulator to evaluate crossrange and downrange site redesignations at various times up to 6 minutes after PDI. The results indicate that the trajectories meet the nominal high-gate conditions and that the cost is approximately 10 feet per second per nautical mile, up to 3 nm.

(NASA-CR-106868) DELTA V COST OF UPDATING  
THE LANDING SITE DURING THE LM DESCENT  
BRAKING PHASE (Bellcomm, Inc.) 7 p

N79-72538

00/20      Unclassified  
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MEMORANDUM FOR FILE

A change is being made in the LM Luminary computer program to permit DSKY updating of the landing site location. This is being implemented as a substitute for LM state vector updating (using MSFN tracking data) which is felt to be operationally too difficult to do after DOI [1]. This study was made to evaluate the  $\Delta V$  cost and the effectiveness of this navigation correction technique when used in the powered descent braking phase.

Data was generated using the Bellcomm Powered Flight Performance Simulation computer program for 37 integrated trajectory simulations. The program was modified to accept landing site updates during the braking phase. The current trajectory parameters specified by FM2/Landing Analysis Branch, MSC [2] were used.

All cases simulated met the nominal high-gate conditions within the granularity of the program, which results from the LGC 2-second cycle time. No trajectory constraint violations were encountered.

The attached table contains data extracted from the simulations, indicating the effects on throttle-down time, switchover time, and the time of touchdown for the specified update magnitudes and redesignation times. Crossrange updates subsequent to the first were all made in one direction since the results are symmetrical. Downrange updates were made in both positive and negative directions.

The total  $\Delta V$  from PDI to touchdown given in Table I is presented in Figures 1 and 2 as a function of the magnitude of the update. Each curve represents a different time at which the redesignation was entered at the DSKY.

The  $\Delta V$  cost for crossrange updates varies significantly with the time since PDI at which the update is made. For an 18,000-foot update, for example, the cost of the redesignation is 0 feet per second if made at PDI and 23 feet per second if made 6 minutes after PDI.

The  $\Delta V$  cost of downrange updates is independent of the time at which they are made, up to 6 minutes after PDI. Figure 2 indicates the strong dependence on direction and magnitude of the update. In the ranges examined, the cost is approximately 10 fps/nm.

In summary, landing site update during the braking phase is a feasible technique for correcting navigation errors. The  $\Delta V$  cost is economical for a redesignation of up to 3 nm if made within 6 minutes after PDI.

*W. H. LaPiana*  
F. LaPiana

*Patty Whitlock*

P. A. Whitlock

2014-<sup>FL</sup><sub>PAW</sub>-ksc

Attachment  
Table I  
Figure 1  
Figure 2

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REFERENCES

1. Tindall, Howard W. Jr., NASA-MSC Memo 69-PA-T-114A, August 1, 1969, How to Land Next to a Surveyor - A short novel for do-it-yourselfers.
2. Kirkland, Burl K., NASA-MSC Memo 69-FM22-79, April 8, 1969, LM powered descent targets used to generate the Mission G Operational Trajectory.

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TABLE I

SITE UPDATE	REDESIGNATION	TIME SINCE THROTTLE-DOWN	PDI	TOUCHDOWN	TOTAL $\Delta V$
NOMINAL	0	388	502	715	6775
CROSS RANGE					
+6000.	0	388	502	715	6775
-6000.	0	388	502	715	6775
	120	388	502	715	6775
	240	388	502	715	6775
	360	388	502	715	6777
-12,000	0	388	502	715	6775
	120	388	502	715	6775
	240	388	502	715	6776
	360	390	502	715	6781
-15,000	240	388	502	715	6777
	360	390	502	715	6787
-18,000	0	388	502	715	6775
	120	388	502	715	6776
	240	388	502	715	6779
	360	392	504	717	6798
DOWN RANGE					
+18,000	0	374	514	728	6801
	120	374	514	728	6800
	360	378	514	728	6801
+12,000	0	378	510	724	6794
	120	380	510	724	6790
	240	380	510	724	6794
	360	380	510	725	6795
+6000	0	384	506	720	6787
	120	384	506	720	6786
	240	384	506	720	6786
	360	384	506	720	6786
-6000	0	394	498	711	6766
	120	394	498	711	6766
	240	392	498	710	6764
	360	392	498	710	6765
-12,000	0	398	492	705	6756
	120	398	492	705	6752
	240	398	492	706	6754
	360	398	492	706	6755
-18,000	0	404	488	700	6744
	120	404	488	701	6746
	360	402	488	701	6748

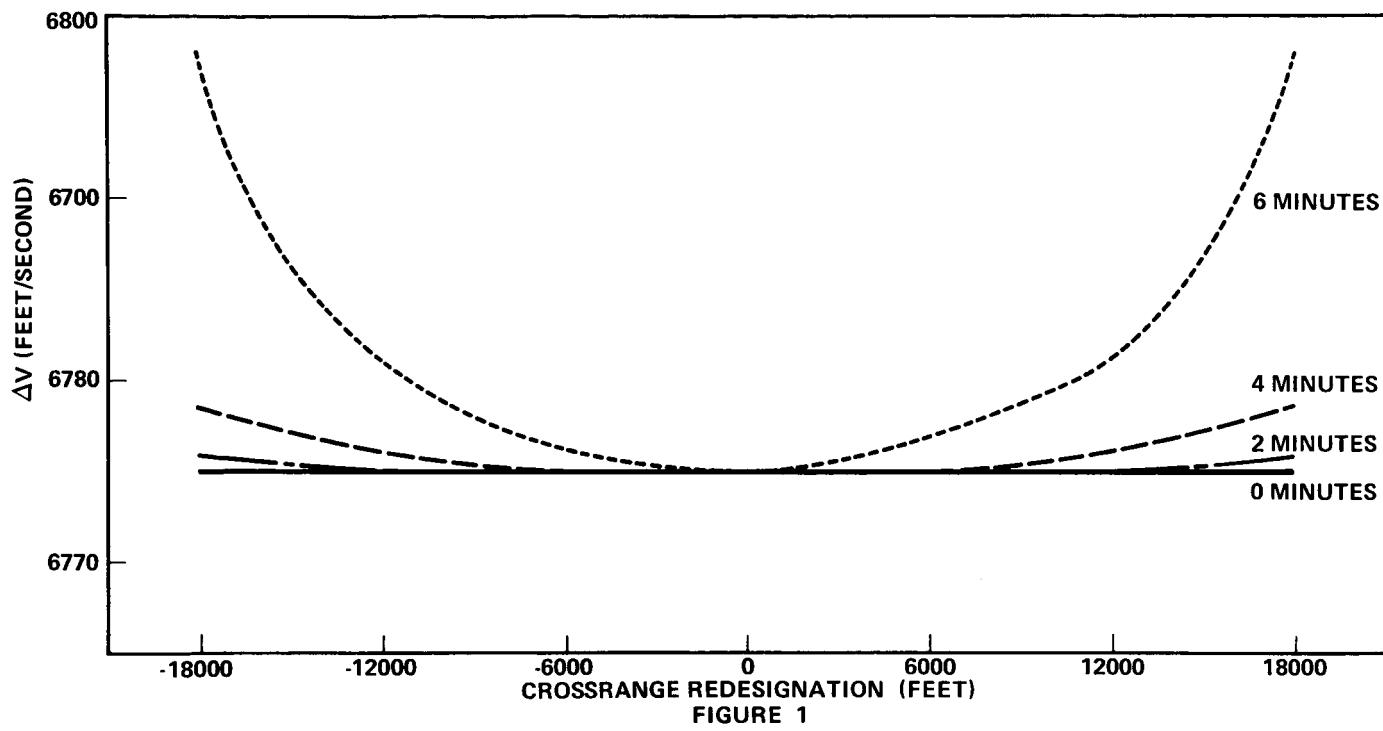


FIGURE 1

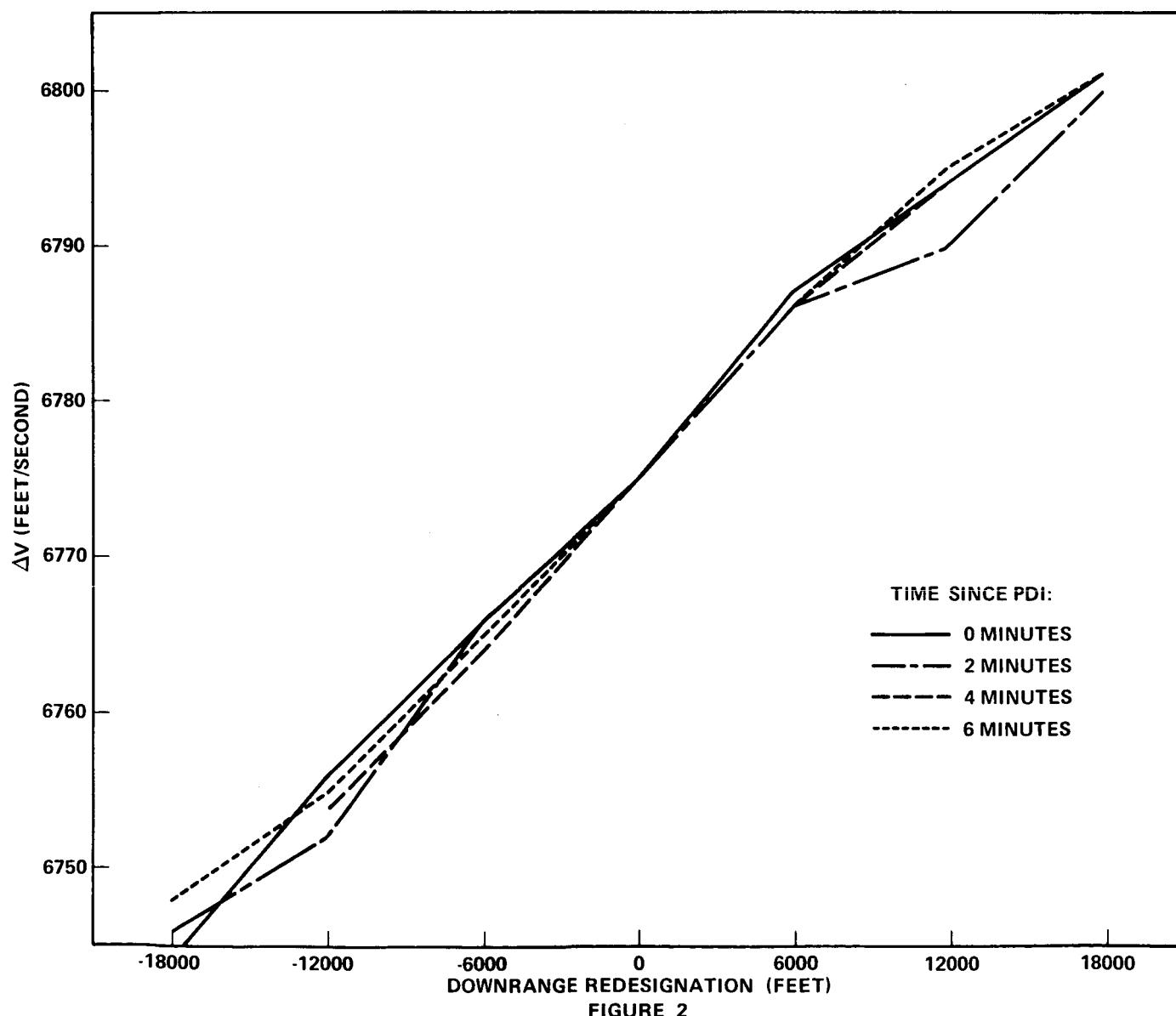


FIGURE 2

**BELLCOMM, INC.**

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